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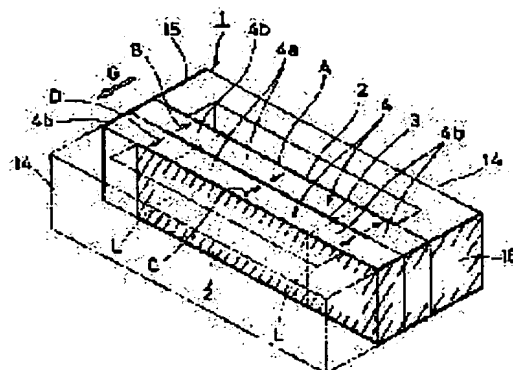
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## (54) ACCELERATION SENSOR

## (57)Abstract:

**PURPOSE:** To provide an acceleration sensor whose detection sensitivity can be enhanced, which can be made small-sized and whose production efficiency can be enhanced sharply.

**CONSTITUTION:** In an acceleration sensor, one pair of piezoelectric ceramic sheets 4 which have been formed into strip shapes and in which signal extraction electrodes 2 and intermediate electrodes 3 have been formed on respective main surfaces are provided, and both end edges along the lengthwise direction of a bimorph-type detection element 1 integrated by bonding opposite faces of the intermediate electrodes 3 on the piezoelectric ceramic sheets 4 are fixed and supported. In the acceleration sensor, respective length-direction regions on the piezoelectric ceramic sheets 4 are divided into three parts 4a, 4b by boundary lines L in which a stress generated by the action of an acceleration G is changed, the central part 4a and the end parts 4b are polarized according to direction (A, B and C, D) which are mutually reversed along the sheet-thickness direction, and the polarizing directions (A, C and B, D) in the central part 4a and the end parts 4b in the piezoelectric ceramic sheets 4 are made mutually different.



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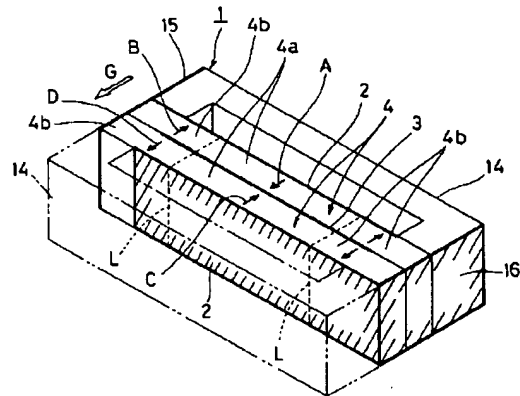
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(54)【発明の名称】 加速度センサ

(57)【要約】

【目的】検出感度の向上及び小型化を図りつつ、生産効率の大幅な向上を実現することができる加速度センサを提供する。

【構成】短冊形状とされたうえで主表面のそれぞれ上に信号取出電極2及び中間電極3が形成された一対の圧電セラミック板4を備え、これら圧電セラミック板4上の中間電極3同士を対面接合して一体化したバイモルフ型検出素子1の長手方向に沿う両端縁を固定支持してなる加速度センサであり、圧電セラミック板4それぞれの長手方向領域を加速度Gの作用に伴って発生する応力に変化する境界線Lによって区分けされた3つの部分4a、4bに区分すると共に、その中央部分4a及び端部分4bそれぞれを板厚方向に沿いつつ互いに逆となる向き(A、BとC、D)に従って分極する一方、圧電セラミック板4の中央部分4a及び端部分4b同士における分極の向き(A、CとB、D)を相互に異ならせている。



1

## 【特許請求の範囲】

【請求項1】 共に短冊形状とされたうえで主表面のそれぞれ上に信号取出電極(2)及び中間電極(3)が形成された一対の圧電セラミック板(4)を備え、かつ、これら圧電セラミック板(4)上の中間電極(3)同士を対面接合して一体化したバイモルフ型検出素子(1)の長手方向に沿う両端縁を固定支持してなる構造の加速度センサであって、

圧電セラミック板(4)それぞれの長手方向領域を加速度(G)の作用に伴って発生する応力が変化する境界線(L)によって区分けされた3つの部分(4a、4b)に区分すると共に、その中央部分(4a)及び端部分(4b)それぞれを板厚方向に沿いつつ互いに逆となる向き(A、BとC、D)に従って分極する一方、両圧電セラミック板(4)の中央部分(4a)及び端部分(4b)同士における分極の向き(A、CとB、D)を相互に異ならせていることを特徴とする加速度センサ。

## 【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は加速度センサに係り、詳しくは、これを構成する際に用いられるバイモルフ型検出素子の構造に関する。

【0002】

【従来の技術】従来から、加速度センサのうちには圧電性素子を組み込んで構成されたものがあり、この種の圧電性素子としては、図3で示すような両持ち梁構造といわれるバイモルフ型検出素子(以下、検出素子という)10を利用するのが一般的となっている。すなわち、この検出素子10は、共に短冊形状とされたうえで主表面それぞれ上に信号取出電極11及び中間電極12が形成された一対の圧電セラミック板13を備え、かつ、これらが中間電極12同士の対面接合によって一体化されたものであり、圧電セラミック板13の各々は板厚方向に沿いつつ他方側とは互いに逆となる向き(図では、矢印X、Yで示す)に従って分極されている。

【0003】そして、この検出素子10の長手方向に沿う両端縁は側面視「コ」字形状となった一対の挟持部品14によって固定支持されており、各圧電セラミック板13上に形成された信号取出電極11のそれぞれは挟持部品14及びこれらの上下位置に取り付けられたケース部品(図示していない)それぞれの異なる端面ごとに形成された外部引出電極15、16の各々に対して接続されている。なお、挟持部品14が上記形状とされているのは、これらの挟持部品14及びケース部品の全体に対して加速度Gが作用した際、この加速度Gの作用に伴う慣性力によって変形する検出素子10の撓み代を確保するためである。

【0004】一方、近年では、加速度センサに対してより一層の小型化が要望されていることから、検出素子自

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体の小型化をも図る必要が生じている。しかしながら、両持ち梁構造の検出素子10をそのまま小型化したのでは、加速度Gの作用時における変形が小さくなり、この変形による電荷の発生量が小さくなり過ぎる結果、検出感度の大幅な低下を招いてしまう。そこで、同じ大きさの加速度Gが作用した場合にはより大きく変形しうる片持ち梁構造、例えば、図4で示すような構造とされた検出素子20を利用して検出感度の高い加速度センサを構成することが行われるようになってきた。

【0005】すなわち、この検出素子20は上記検出素子10と同構成でありながらも長手方向に沿う寸法がより短くなった一対の圧電セラミック板21を備えたものであり、その一方の端縁のみが一対の挟持部品14によって固定支持された構造となっている。そして、この検出素子20における各圧電セラミック板21上に形成された信号取出電極11のそれぞれは挟持部品14及びケース部品の同一となる端面上に離間して形成された外部引出電極15、16の各々に対して接続されている。なお、検出素子20の全体構造は検出素子10と基本的に異ならないから、図4において図3と互いに同一となる部品には同一符号を付し、ここでの説明は省略する。

【0006】

【発明が解決しようとする課題】ところで、両持ち梁構造とされた検出素子10を製作する際には、図5で示すように、信号取出電極11及び中間電極12となる電極パターン(図示していない)が主表面のそれぞれ上に予め形成された圧電セラミック板13用のセラミック親基板17と、内表面側の所定位置ごとに所定幅の凹溝が形成された挟持部品用親基板18とをそれぞれ用意したうえで、中間電極12となる電極パターンを挟んで対面配置されたセラミック親基板17それぞれの外側から挟持部品用親基板18の各々を当てつけて一体に接合した後、これらを所定の切断線Sに沿って切断するのが一般的である。

【0007】そして、片持ち梁構造の検出素子20を製作するに際しても、両持ち梁構造と同じ製作手順が踏襲されるのであるが、この場合には、図5中の仮想線で示すように、圧電セラミック板21の寸法を圧電セラミック板13よりも短くするための所定幅とされた貫通溝22をセラミック親基板23の所定位置ごとに予め形成しておく必要がある。そのため、わざわざ貫通溝22が形成されたセラミック親基板23を用意するための多大な手間がかかることになってしまう。また、貫通溝22が形成されたセラミック親基板23相互及びこれらに対する挟持部品用親基板18の位置決めを正確に行っておかなければ片持ち梁構造とすることが不可能となる恐れもあり、この点でも面倒な手間を要することになっていた。

【0008】さらにまた、片持ち梁構造を採用した場合には両持ち梁構造の場合に比較して耐衝撃性に劣ること

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になり、強度的に弱くなることが避けられないのは勿論であるほか、片持ち梁構造の検出素子20においては、信号取出電極11のそれぞれが挟持部品14及びケース部品の同一となる端面上に集中して引き出されており、通常の電子部品とは異なっていることになる結果、加速度センサが実装される配線基板側での配線パターン変更を要するというような不都合も生じていた。

【0009】本発明は、これらの不都合に鑑みて創案されたものであって、検出感度の向上及び小型化を図りつつ、生産効率の大幅な向上を実現することができる加速

度センサの提供を目的としている。

【0010】

【課題を解決するための手段】本発明に係る加速度センサは、共に短冊形状とされたうえで主表面のそれぞれ上に信号取出電極及び中間電極が形成された一対の圧電セラミック板を備え、かつ、これら圧電セラミック板上の中間電極同士を対面接合して一体化した検出素子の長手方向に沿う両端縁を固定支持してなるものであって、圧電セラミック板それぞれの長手方向領域を加速度の作用に伴って発生する応力が変化する境界線によって区分け

された3つの部分に区分すると共に、その中央部分及び端部分それぞれを板厚方向に沿いつつ互いに逆となる向きに従って分極する一方、両圧電セラミック板の中央部分及び端部分同士における分極の向きを相互に異ならせている。

【0011】

【実施例】以下、本発明の実施例を図面に基づいて説明する。

【0012】図1は本実施例に係る加速度センサを構成する際に用いられる検出素子のみを取り出して示す外観斜視図、図2は加速度の作用時における検出素子の変形状態を模式的に示す説明図であり、これらの図における符号1は両持ち梁構造とされた検出素子である。なお、これらの図1及び図2において図3及び図4と互いに同一となる部品には、同一の符号を付している。また、検出素子1の製作手順は従来例に係る検出素子10と同じであるから、ここでの説明は省略する。

【0013】本実施例に係る検出素子1は、共に短冊形状とされたうえで主表面のそれぞれ上に薄膜状の信号取出電極2及び中間電極3が形成された一対の圧電セラミック板4を備え、かつ、中間電極3同士を対面接合することによって両圧電セラミック板4が一体化されたものであり、従来例における両持ち梁構造の検出素子10と同様、この検出素子1の長手方向に沿う両端縁は側面視「コ」字形状となった一対の挟持部品14によって固定支持されている。そして、この検出素子1を構成する圧電セラミック板4それぞれの長手方向領域は、加速度Gの作用に伴って発生する応力が変化する境界線L(後述する)によって区分けされた3つの部分4a、4bに区分されており、しかも、その中央部分4a及び端部分4

bのそれぞれは各圧電セラミック板4の板厚方向に沿いつつ互いに逆となる向き(図では、矢印A、BとC、Dで示す)に従って分極されている。

【0014】また、このとき、互いに一体化されて検出素子1を構成する両圧電セラミック板4の中央部分4a及び端部分4b同士における分極の向きA、B及びC、Dの各々は相互に異ならされている。すなわち、例えば、各圧電セラミック板4の中央部分4aそれぞれにおける分極の向きA及びCは互いに近づく内向きとされる一方、両者の端部分4bにおける分極の向きB及びDは互いに遠ざかる外向きとされている。そして、各圧電セラミック板4上に形成された信号取出電極2のそれぞれは挟持部品14及びこれらの上下位置に取り付けられたケース部品(図示していない)それぞれの互いに異なる端面ごとに形成された外部引出電極15、16の各々に対して接続されている。

【0015】ここで、各圧電セラミック板4の長手方向領域を3つの部分4a、4bに区分する応力変化の境界線L、すなわち、加速度Gの作用に伴って各圧電セラミック板4に発生した応力が「引っ張り」及び「圧縮」とに区分けされる変化の境界線Lを図2に基づいて説明する。

【0016】まず、加速度センサの全体に対して加速度Gが作用すると、検出素子1を固定支持する挟持部品14及びケース部品に対しては加速度Gが直接的に作用することになり、これらの挟持部品14及びケース部品は共に加速度Gの作用方向に沿って移動しようとする。ところが、この際においても、検出素子1に対して直接的な加速度Gが作用することはないから、検出素子1は加速度Gの作用する以前における状態をそのまま維持し続けようとし、この検出素子1には加速度Gの作用に伴って発生した慣性力が作用することになる。そこで、検出素子1を構成する各圧電セラミック板4の端部分4bそれぞれはこれらを固定支持する挟持部品14と共に移動しようとする一方、各々の中央部分4aそれぞれは当初位置のまま残ろうとする結果、この検出素子1は加速度Gの作用側に向かって撓んだ湾曲形状(図では、上向きの凸形状)となるように変形する。

【0017】そのため、図2で示すように、撓み方向外側(図では、上側)に位置する圧電セラミック板4の中央部分4aには引っ張り応力Pt、また、その端部分4bには圧縮応力Pcが現れることになる一方、撓み方向内側(図では、下側)に位置する圧電セラミック板4の中央部分4aには圧縮応力Pc、また、その端部分4bには引っ張り応力Ptが現れることになる。すなわち、本実施例に係る検出素子1においては、各圧電セラミック板4の長手方向領域に沿って現れる応力が「引っ張り」から「圧縮」へ、また、「圧縮」から「引っ張り」へと変わる境界を応力が変化する境界線Lとしたうえ、これらの境界線Lによって区分けされた各圧電セラミ

ク板4の中央部分4a及び端部分4bのそれぞれを互いに逆となる向きA、B及びC、Dに従って分極しているのである。なお、この境界線は、例えば、数値解析手法の一つである有限要素法を利用した実験によって知ることが可能なものである。

【0018】つぎに、上記構造とされた検出素子1の動作及び作用について説明する。

【0019】加速度センサに対して加速度Gが作用し、図2で示したような変形が検出素子1に生じた場合、この検出素子1の撓み方向外側に位置する圧電セラミック板4の中央部分4aにおける外側主表面には分極の向きAと引っ張り応力P<sub>t</sub>との関係に基づいて正(+)の電荷が発生し、また、その端部分4bにおける外側主表面でも分極の向きB及び圧縮応力P<sub>c</sub>の関係から正の電荷が発生する。そこで、この圧電セラミック板4の中央部分4a及び端部分4bそれぞれの外側主表面に発生した正の電荷は互いに強めあひながら、信号取出電極2から外部引出電極15へと伝わることになる。さらに、このとき、検出素子1の撓み方向内側に位置する圧電セラミック板4の中央部分4aにおける外側主表面には分極の向きCと圧縮応力P<sub>c</sub>との関係から負(-)の電荷が発生し、また、その端部分4bにおける外側主表面にも分極の向きDと引っ張り応力P<sub>t</sub>との関係から負の電荷が発生することになり、これら負の電荷は信号取出電極2から外部引出電極16へと伝わることになる。

【0020】したがって、この検出素子1によれば、これが従来例である検出素子10と同様の両持ち構造を有しているにも拘わらず加速度Gの作用時における電荷の発生量が増えることになる結果、その小型化を行っても検出感度の低下は起こらないことになる。なお、加速度Gが作用した際における圧電セラミック板4それぞれの内側主表面には各々の外側主表面と異なる正もしくは負の電荷が発生しているが、これらの電荷は中間電極3を通じて互いに打ち消されることになり、外部に対しては何らの影響をも及ぼさないことになる。

【0021】ところで、前記従来例の両持ち梁構造とされた検出素子10を構成する各圧電セラミック板13ではその長手方向領域の全体にわたる分極の向きX、Yが図3で示したような同一方向であるために不都合が生じていたのである。すなわち、図示していないが、加速度Gが作用した場合には、検出素子10を構成する圧電セラミック板13においても本実施例の場合と同じく図2で

示したような応力状態が現れることになる。しかしながら、この検出素子10の各圧電セラミック板13における分極の向きX、Yが同一となっているから、変形した検出素子1の撓み方向外側に位置する圧電セラミック板4の中央部分に正の電荷が発生した場合の端部分には負の電荷が発生することになり、また、撓み方向内側に位置する圧電セラミック板4の中央部分に負の電荷が発生した場合の端部分には正の電荷がそれぞれ発生することになってしまう。そのため、各圧電セラミック板13の同一主表面に発生した正負の電荷が互いに打ち消しあうことになる結果、検出感度が低下することになっていたのである。

【0022】

【発明の効果】以上説明したように、本発明に係る加速度センサの検出素子によれば、これが両持ち梁構造であるにも拘わらず加速度の作用時における電荷の発生量が増えることになり、その小型化を行っても検出感度の低下は起こらないことになる。したがって、片持ち梁構造の検出素子を採用したうえで加速度センサに組み込む必要はないことになり、片持ち構造の検出素子を採用した際に生じていた種々の不都合を回避できる。その結果、検出感度の向上及び小型化を図りつつ、生産効率の大幅な向上を実現することができるという効果が得られる。

【図面の簡単な説明】

【図1】本実施例に係る加速度センサの検出素子を示す外観斜視図である。

【図2】加速度の作用時における検出素子の変形状態を模式的に示す説明図である。

【図3】従来例に係る両持ち梁構造の検出素子を示す外観斜視図である。

【図4】従来例に係る片持ち梁構造の検出素子を示す外観斜視図である。

【図5】検出素子の製作手順を示す分解斜視図である。

【符号の説明】

1 検出素子(バイモルフ型検出素子)

2 信号取出電極

3 中間電極

4 圧電セラミック板

4a 中央部分

4b 端部分

L 境界線

G 加速度



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CLAIMS

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[Claim(s)]

[Claim 1] After considering as the shape of both rectangle, it has the piezo-electric ceramic plate of a pair on the front face of main (4) with which the signal fetch electrode (2) and the bipolar electrode (3) were formed upwards, respectively. And it is the acceleration sensor of the structure which comes to carry out fixed support of the both-ends edge in alignment with the longitudinal direction of the bimorph mold sensing element (1) which carried out confrontation junction of the bipolar electrodes (3) on a these piezo-electricity ceramic plate (4), and was unified. Piezo-electric ceramic plate (4) While classifying into three parts (4a, 4b) classified according to the boundary line (L) from which the stress generated with each longitudinal direction field to an operation of acceleration (G) changes While the central part (4a) and each edge part (4b) are polarized according to the sense (A, B, C, D) which becomes reverse mutually, meeting in the direction of board thickness The acceleration sensor characterized by changing the sense (A, C, B, D) of polarization in the central part (4a) and edge parts (4b) of a both piezo-electricity ceramic plate (4) mutually.

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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to an acceleration sensor and relates to the structure of the bimorph mold sensing element used in detail in case this is constituted.

[0002]

[Description of the Prior Art] There are some which consisted of the former by including a piezoelectric component in the inside of an acceleration sensor, and it is common as this kind of a piezoelectric component to use the bimorph mold sensing element (henceforth a sensing element) 10 called doubly-supported beam structure as shown by drawing 3. It has the piezo-electric ceramic plate 13 of a pair with which the signal fetch electrode 11 and the bipolar electrode 12 were formed upwards. after [ namely, ] this sensing element 10 is made [ both ] into the shape of a rectangle -- each main front face -- And these are unified by confrontation junction of bipolar electrode 12 comrades, and according to the sense (arrow heads X and Y show by a diagram) which becomes reverse mutually, polarization of it is carried out to the other side, each of the piezo-electric ceramic plate 13 meeting in the direction of board thickness.

[0003] And fixed support of the both-ends edge in alignment with the longitudinal direction of this sensing element 10 is carried out with the pinching components 14 of a pair which became side view "K0" typeface-like. the case components (not shown) with which each of the signal fetch electrode 11 formed on each piezo-electric ceramic plate 13 was attached in the pinching components 14 and these vertical locations -- it connects to each different each of the external drawer electrodes 15 and 16 formed for every end face. In addition, the pinching components 14 are made into the above-mentioned configuration for securing the bending cost of the sensing element 10 which deforms with the inertial force accompanying an operation of this acceleration G, when acceleration G acts to these pinching components 14 and the whole case component.

[0004] On the other hand, in recent years, since much more miniaturization is demanded to the acceleration sensor, it will be necessary to also attain the miniaturization of the sensing element itself. However, in having miniaturized the sensing element 10 of doubly-supported beam structure as it was, as a result of the

deformation at the time of an operation of acceleration G becoming small and the yield of the charge by this deformation becoming small too much, the sharp fall of detection sensitivity will be caused. So, when the acceleration G of the same magnitude acts, constituting the high acceleration sensor of detection sensitivity using the sensing element 20 made into the cantilever structure which may deform more greatly, for example, structure as shown by drawing 4 , has come to be performed.

[0005] That is, this sensing element 20 is equipped with the piezo-electric ceramic plate 21 of a pair with which the dimension in alignment with a longitudinal direction became shorter though it is the above-mentioned sensing element 10 and this configuration, and it has the structure where fixed support only of the edge of one of these was carried out with the pinching components 14 of a pair. And each of the signal fetch electrode 11 formed on each piezo-electric ceramic plate 21 in this sensing element 20 is connected to each of the external drawer electrodes 15 and 16 estranged and formed on the end face which becomes the same [ the pinching components 14 and case components ]. In addition, since the whole sensing element 20 structure does not differ from a sensing element 10 fundamentally, the same sign is given to the components which become the same mutually with drawing 3 in drawing 4 , and explanation here is omitted.

[0006]

[Problem(s) to be Solved by the Invention] by the way, in case the sensing element 10 made into doubly-supported beam structure is manufactured As drawing 5 shows, in the main front face, the electrode pattern (not shown) used as the signal fetch electrode 11 and a bipolar electrode 12 each The ceramic parent substrate 17 for piezo-electric ceramic plate 13 formed beforehand upwards, After preparing the parent substrate 18 for pinching components with which the concave of predetermined width of face was formed for every predetermined location by the side of an internal surface, respectively, the ceramic parent substrate 17 by which confrontation arrangement was carried out on both sides of the electrode pattern used as a bipolar electrode 12 -- after insinuating each of the parent substrate 18 for pinching components from each outside and joining to one, it is common to cut these along with the predetermined cutting plane line S.

[0007] And even if it faces manufacturing the sensing element 20 of cantilever structure, the same fabrication sequence as doubly-supported beam structure is followed, but in this case, as the imaginary line in drawing 5 shows, it is necessary to form beforehand the penetration slot 22 made into the predetermined width of face for making the dimension of

the piezo-electric ceramic plate 21 shorter than the piezo-electric ceramic plate 13 for every predetermined location of the ceramic parent substrate 23. Therefore, the great time and effort for preparing the ceramic parent substrate 23 with which the penetration slot 22 was formed specially will be taken. Moreover, this point was also for there to be also a possibility that considering as cantilever structure may become impossible, if the parent substrate 18 for pinching components to both ceramic parent substrate 23 and these in which the penetration slot 22 was formed is not positioned correctly, and to take troublesome time and effort.

[0008] When cantilever structure is adopted, as compared with the case of doubly-supported beam structure, will be inferior to shock resistance further again. It is natural and also sets that becoming weak in reinforcement is not avoided to the sensing element 20 of cantilever structure. Each of the signal fetch electrode 11 concentrated on the end face which becomes the same [ the pinching components 14 and case components ], and was pulled out, and as a result of differing from the usual electronic parts, it had also produced un-arranging [ of having required circuit pattern modification by the side of the wiring substrate with which an acceleration sensor is mounted ].

[0009] This invention aims at these offers of the acceleration sensor which can realize large improvement in productive efficiency, taking an example inconvenient, being originated and attaining improvement and a miniaturization of detection sensitivity.

[0010]

[Means for Solving the Problem] Both the acceleration sensors concerning this invention are equipped with the piezo-electric ceramic plate of a pair on the front face of main with which the signal fetch electrode and the bipolar electrode were formed upwards, respectively after considering as the shape of a rectangle. And it is the thing which comes to carry out fixed support of the both-ends edge in alignment with the longitudinal direction of the sensing element which carried out confrontation junction of the bipolar electrodes on a these piezo-electricity ceramic plate, and was unified. While classifying into three parts classified according to the boundary line from which the stress generated with the longitudinal direction field of each piezo-electric ceramic plate to an operation of acceleration changes While the central part and each edge part are polarized according to the sense which becomes reverse mutually, meeting in the direction of board thickness, the sense of polarization in the central part and edge parts of a both piezo-electricity ceramic plate is changed mutually.

[0011]

[Example] Hereafter, the example of this invention is explained based on a drawing.

[0012] The appearance perspective view and drawing 2 which take out and show only the sensing element used in case drawing 1 constitutes the acceleration sensor concerning this example are the explanatory view showing typically the deformation condition of the sensing element at the time of an operation of acceleration, and the sign 1 in these drawings is the sensing element made into doubly-supported beam structure. In addition, the same sign is given to the components which become the same mutually with drawing 3 and drawing 4 in these drawing 1 and drawing 2 . Moreover, since the fabrication sequence of a sensing element 1 is the same as the sensing element 10 concerning the conventional example, explanation here is omitted.

[0013] Both the sensing elements 1 concerning this example are equipped with the piezo-electric ceramic plate 4 of a pair on the front face of main with which thin film-like the signal fetch electrode 2 and a bipolar electrode 3 were formed upwards, respectively after considering as the shape of a rectangle. And the both piezo-electricity ceramic plate 4 is unified by carrying out confrontation junction of the bipolar electrode 3 comrades. Fixed support of the both-ends edge in alignment with the longitudinal direction of this sensing element 1 is carried out with the pinching components 14 of a pair which became side view "K0" typeface-like like the sensing element 10 of the doubly-supported beam structure in the conventional example. and the piezo-electric ceramic plate 4 which constitutes this sensing element 1 -- each longitudinal direction field It is classified into three parts 4a and 4b classified according to the boundary line L (it mentions later) from which the stress generated with an operation of acceleration G changes. And polarization of it is carried out according to the sense (arrow heads A, B, and C and D show by a diagram) which becomes reverse mutually, each of the central partial 4a and edge partial 4b meeting in the direction of board thickness of each piezo-electric ceramic plate 4.

[0014] Moreover, if the sense A and B of polarization and each of C and D in central partial 4a of the both piezo-electricity ceramic plate 4 and edge partial 4b which are unified mutually and constitute a sensing element 1 at this time are \*\*, it \*\*\*\*s them mutually. namely, central partial 4a of each piezo-electric ceramic plate 4 -- while the sense A and C of polarization which boils, respectively and can be set is mutually made into the sense in \*\*\*\*\*, the sense B and D of polarization in both edge partial 4b is made into the outwardness which

keeps away mutually. and the case components (not shown) with which each of the signal fetch electrode 2 formed on each piezo-electric ceramic plate 4 was attached in the pinching components 14 and these vertical locations -- it connects to each mutually different each of the external drawer electrodes 15 and 16 formed for every end face.

[0015] Here, the boundary line L L of stress change which classifies the longitudinal direction field of each piezo-electric ceramic plate 4 into three parts 4a and 4b, i.e., the boundary line of change by which the stress generated to each piezo-electric ceramic plate 4 with the operation of acceleration G is classified into "hauling" and "compression", is explained based on drawing 2 .

[0016] First, if acceleration G acts to the whole acceleration sensor, to the pinching components 14 and case components which carry out fixed support of the sensing element 1, acceleration G will act directly and these pinching components 14 and case components tend to move along both the operation directions of acceleration G. However, since the direct acceleration G does not act to a sensing element 1 in this case, a sensing element 1 tends to continue maintaining the condition before acceleration G acts as it is, and the inertial force generated with the operation of acceleration G will act on this sensing element 1. then , edge partial 4b of each piezo-electric ceramic plate 4 which constitute a sensing element 1 -- while each tend to move with the pinching components 14 which carry out fixed support of these -- each central partial 4a -- as a result of each remain at the beginning with a location , this sensing element 1 deform so that it may become the curve configuration (convex configuration upward in drawing ) where it bent toward the operation side of acceleration G .

[0017] Therefore, as drawing 2 shows, while compressive stress Pc will appear in a tensile stress Pt and its edge partial 4b at central partial 4a of the piezo-electric ceramic plate 4 located in the bending direction outside (drawing on), in compressive stress Pc and its edge partial 4b, a tensile stress Pt will appear at central partial 4a of the piezo-electric ceramic plate 4 located in the bending direction inside (drawing under). Namely, it sets to the sensing element 1 concerning this example. The stress which appears along the longitudinal direction field of each piezo-electric ceramic plate 4 from "hauling" to "compression" Moreover, after making the boundary which changes from "compression" to "hauling" into the boundary line L from which stress changes, each of central partial 4a of each piezo-electric ceramic plate 4 classified according to these boundary lines L and edge partial 4b is polarized according to the sense A and B which becomes reverse mutually,

and C and D. In addition, this boundary line L can be got to know by the experiment using the finite element method which is one of for example, the numerical-analysis technique.

[0018] Below, the actuation and the operation of a sensing element 1 which were made into the above-mentioned structure are explained.

[0019] When deformation as acceleration G acted to an acceleration sensor and shown by drawing 2 arises in a sensing element 1, In the outside main front face in central partial 4a of the piezo-electric ceramic plate 4 located in the bending direction outside of this sensing element 1, the charge of forward (+) is generated based on the relation between sense A of polarization, and a tensile stress  $P_t$ . Moreover, positive charge occurs from sense [ of polarization ] B, and the relation of compressive stress  $P_c$  also on the outside main front face in the edge partial 4b. then, central partial 4a of this piezo-electric ceramic plate 4 and edge partial 4b -- while the positive charge generated on each outside main front face suits in slight strength mutually, it will be transmitted from the signal fetch electrode 2 to the external drawer electrode 15. Furthermore, in the outside main front face in central partial 4a of the piezo-electric ceramic plate 4 located inside [ bending direction ] a sensing element 1, the charge of negative (-) is generated from the relation between sense C of polarization, and compressive stress  $P_c$  at this time. Moreover, negative charge will occur from the relation between sense D of polarization, and a tensile stress  $P_t$  also on the outside main front face in the edge partial 4b, and these negative charge will be transmitted from the signal fetch electrode 2 to the external drawer electrode 16.

[0020] Therefore, although this has both the same \*\*\*\* structure as the sensing element 10 which is the conventional example, as a result of the yield of the charge at the time of an operation of acceleration G increasing according to this sensing element 1, even if it performs that miniaturization, the fall of detection sensitivity will not take place. in addition, the piezo-electric ceramic plate 4 at the time of acting acceleration G -- although forward [ different ] or the negative charge from each outside main front face has occurred in each inside main front face, these charges of each other will be negated through a bipolar electrode 3, and will not do any effect to the exterior, either.

[0021] By the way, with each piezo-electric ceramic plate 13 which constitutes the sensing element 10 made into said conventional doubly-supported beam structure, since it was the same direction as the sense X and Y of the whole longitudinal direction field polarization showed by drawing 3 R> 3, un-arranging had arisen. That is, although not

illustrated, when acceleration G acts, a stress condition as shown [ in / as well as the case of this example / the piezo-electric ceramic plate 13 which constitutes a sensing element 10 ] by drawing 2 will appear. However, since the sense X and Y of polarization in each piezo-electric ceramic plate 13 of this sensing element 10 is the same Negative charge will occur into an edge part when positive charge occurs into the central part of the piezo-electric ceramic plate 4 located in the bending direction outside of the sensing element 1 which deformed. Moreover, into an edge part when negative charge occurs into the central part of the piezo-electric ceramic plate 4 located in the bending direction inside, positive charge will occur, respectively. Therefore, detection sensitivity was to fall, as a result of the forward negative charge generated on the same main front face of each piezo-electric ceramic plate 13 denying mutually and suiting.

[0022]

[Effect of the Invention] As explained above, although this is doubly-supported beam structure, even if the yield of the charge at the time of an operation of acceleration will increase and it performs the miniaturization, according to the sensing element of the acceleration sensor concerning this invention, the fall of detection sensitivity will not take place. Therefore, after adopting the sensing element of cantilever structure, it is necessary to include in an acceleration sensor, and it can avoid various un-arranging [ which had been produced when the sensing element of a cantilever structure was adopted ]. Consequently, the effectiveness that the large improvement in productive efficiency is realizable is acquired, attaining improvement and a miniaturization of detection sensitivity.

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] It is the appearance perspective view showing the sensing element of the acceleration sensor concerning this example.

[Drawing 2] It is the explanatory view showing typically the deformation condition of the sensing element at the time of an operation of acceleration.

[Drawing 3] It is the appearance perspective view showing the sensing element of the doubly-supported beam structure concerning the conventional example.

[Drawing 4] It is the appearance perspective view showing the sensing element of the cantilever structure concerning the conventional example.

[Drawing 5] It is the decomposition perspective view showing the fabrication sequence of a sensing element.

[Description of Notations]

1 Sensing Element (Bimorph Mold Sensing Element)

2 Signal Fetch Electrode

3 Bipolar Electrode

4 Piezo-electric Ceramic Plate

4a Central part

4b Edge part

L Boundary line

G Acceleration

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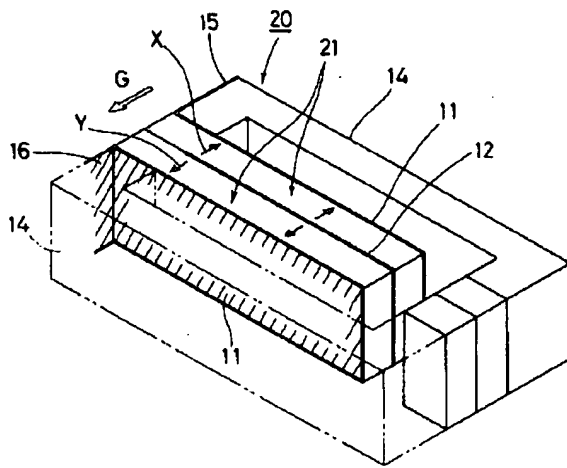
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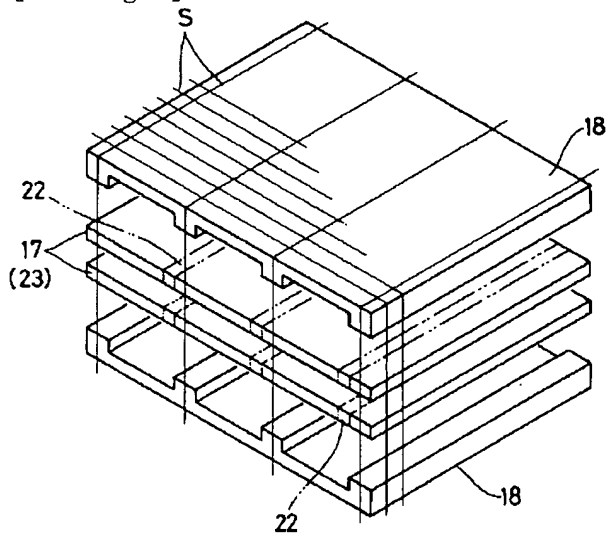
DRAWINGS

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[Drawing 5]




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